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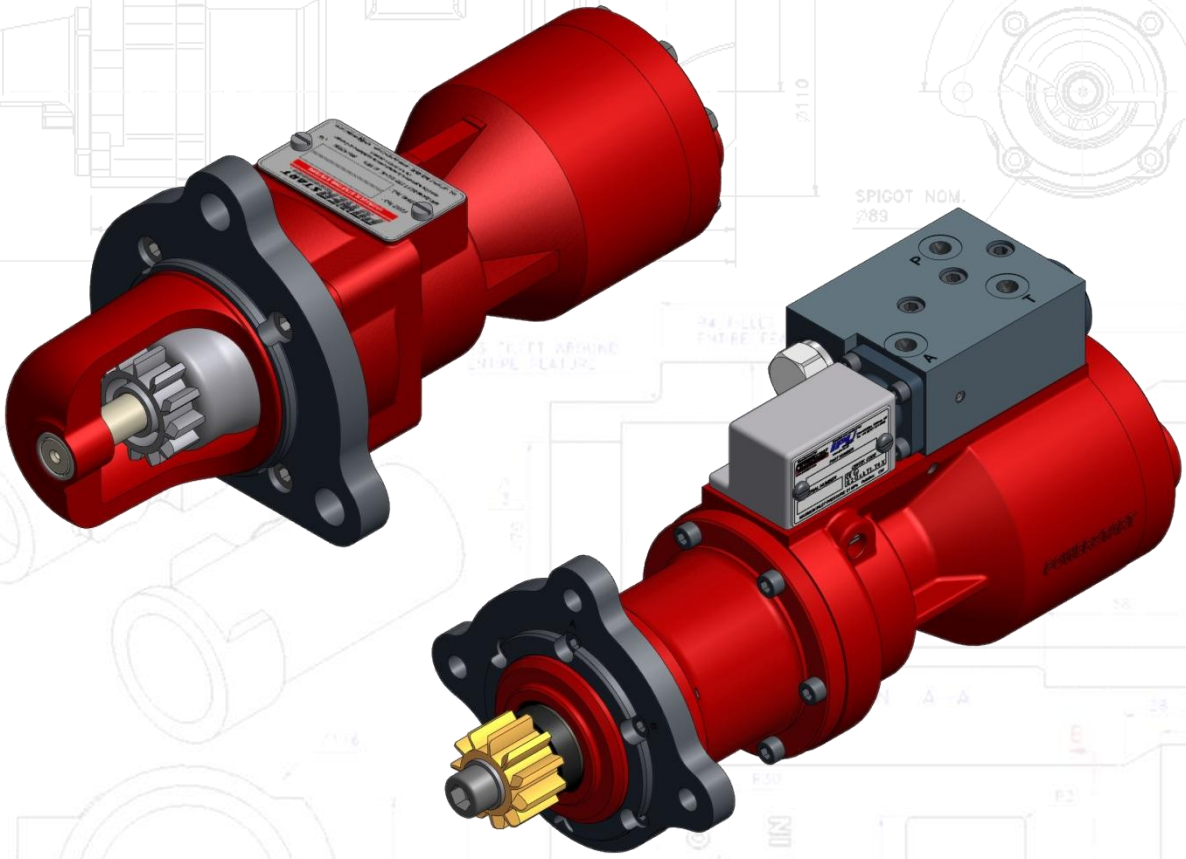
Powerstart M22 and M28 Hydraulic Starters

Inertia and Pre-engaged



Installation and Operating Instructions

SAFETY FIRST

- **IMPORTANT SAFETY INFORMATION ENCLOSED**
- **Read and understand this manual before operating the starter.**
- **Failure to properly install or operate the starter may result in damage to the starter and/or engine, cause personal severe injury and invalidate the warranty.**

- Always install, operate and maintain this product in accordance with all applicable standards, regulations and laws.
- Do not exceed the starter pressure rating as specified on the nameplate.
- Do not work on any starter or starter installation unless all pressure has been drained from the system.
- Never use damaged fittings or frayed hoses.
- Repairs should only be undertaken by authorised and trained personnel.
- The use of non genuine Powerstart spares or the servicing by unauthorised personnel may result in safety hazards, affect performance and invalidate all warranties.
- Maximum inlet pressure rating is 21 MPa
- Maximum pinion speed 4000 rpm.

1. General

This installation manual should be read and fully understood prior to installation and commissioning of your Powerstart hydraulic starter.

WARNING – Powerstart pre-engaged hydraulic starters must be installed and operated in accordance with the instructions given in this document. Failure to properly install or operate the starter may result in damage to the starter and/or the engine, cause personal severe injury and invalidate the warranty.

2. Orientation of flange

Inertia Starter

The inertia starter can be oriented to suit the engine configuration and ancillary equipment by removing the four M8 socket head screws which hold the flange to the starter body. This will enable the flange to be indexed by 90° increments. These screws should be retightened to 35Nm (25.9 lb.ft.) once the correct positioning has been achieved. A 6mm Allen key should be used.

If slight orientation adjustment of the starter relative to the mounting flange is necessary, i.e. less than 90°, then a different flange may need to be used. In that event, please consult Powerworks or your authorised distributor.

Pre-engaged Starter

The pre-engaged starter can be oriented by removing the six M6 socket head screws which hold the flange to the front of the starter body. The pre-engaged flange can be indexed in 60° increments. The screws should be retightened to 20Nm (15 lb.ft.) once the correct positioning has been achieved. A 5mm Allen key should be used.

3. Installing the starter onto the engine

Prior to mating the starter to the engine, perform a quick check of the distance from the flange mounting face to the ring gear and compare this to the distance from the starter flange to the end of the pinion gear.

For inertia starters, the distance from the flange face to the end of the pinion gear should be approximately 12.5mm (0.5 in.) longer than the flange to ring gear when the pinion is wound all the way forward.

For pre-engaged starters the flange to pinion distance should be approximately 3mm (0.12") shorter than the flange to ring gear distance when the pinion is retracted.

NOTE – The **inertia** starter is supplied with the drive in the forward position. The drive cannot be retracted manually since the detents which hold it in the forward position only release under centrifugal force above a certain rotational speed. This is normal and the drive will retract after the first start.

Mate the starter flange to the engine mounting and check that spigot diameters and mounting holes are correct and line up. There should not be excessive play between the starter and the starter pocket on the engine when the starter is mated. A maximum of 0.25mm (0.01") is permitted. Ensure that the correct mounting bolts are used so as not to protrude into the bell housing and touch the flywheel. In particular, if another starter is being replaced which is different from this one, the flange thickness may differ and the bolts may need to be replaced accordingly.

Tighten the mounting bolts as indicated by the engine manufacturer and observe any thread locking or flange sealing procedures which may be specified.

4. Piping Up and Bleeding

Two typical installation layouts are shown in figures 1 and 2 depending on which starter is used. The components may vary in shape or size, but there should be at least a hand pump, a filter, an accumulator with a relief valve and system hoses.

4.1 Hose Sizes and port sizes

Hose and fittings should be rated to 21 MPa working pressure minimum. Hose sizes should be as follows:
Pressure lines: 3/8"
Return lines: 1/2"
Limit the use of sharp elbows in order to stay within laminar flow.

Inertia starter port sizes:
Starter inlet port: 3/8" NPT
Starter outlet port: 1/2" NPT

Pre-engaged starter port sizes:
Starter inlet port: G 3/8"-19
Starter outlet port: 1/2" NPT
Pilot ports: G 1/8"-28

4.2 Inertia Starter Start Valve

The use of the Powerstart foot operated start valve is recommended, However if an alternate start valve is required, the following parameters should be met:

a. It should be a positive seated poppet style valve
b. Should a pilot operated manual or solenoid valve be used a flow control valve is recommended to ensure smoother operation (especially with beryllium copper pinions)
c. Port sizes are ideally 3/8" and internal passages should not go smaller than this.
d. Valve configuration is a two position two port style, i.e. open and closed.

4.2 Pre-engaged Starter Start Valve

The pre-engaged starter requires a pilot valve for operation since the full flow is only seen by the starter motor itself. The following parameters should be met:

a. It should be a positive seated poppet style valve
b. Valve size can be as small as a 1/8" port valve since it is only a pilot valve.
c. Valve configuration is a two position three port, i.e. it must dump back to the starter (to tank).
d. Do not limit the flow of oil to the starter motor with an orifice.

4.3 Bleeding

Prior to first operation, it is advisable to bleed system of excess air. With inertia starters, this is best achieved as follows:

a. Depressurise the system completely.
b. Disconnect the return line going from the starter back to the reservoir at the reservoir end and place into a bucket or suitable container.
c. Have an assistant open the starting valve and hold it open.
d. Operate the hand pump until the flow of oil from the starter is free of bubbles.

5. Starter Operation

The maximum pinion speed of 4000 rpm should be observed in order to maintain optimum pinion life. Higher operating speeds may cause accelerated wear.

- Ensure engine is in a serviceable condition (oil level, fuel supply, coolant, etc.). **Fuel system must be primed.**
- Disconnect engine from load. Alternatively if load cannot be disconnected, ensure that it is safe to drive the load once the engine rotates and / or fires.
- Activate starter valve.
- If engine fails to start, recharge accumulator with hand pump and repeat above step.
- Release starter valve as soon as the engine has started.
- Repeat the starting procedure a number of times to completely purge the system of air.
- If the system is equipped with an automatic recharge valve check that it is charging the accumulator to system pressure of 21 MPa (3000 psi).

If the engine turns rapidly for approximately 3 - 5 seconds and does not start, the problem is not with the starting system. If oil emerges from the starter motor check that the inlet and outlet connections are correctly connected to the pressure and return lines.

If a flow control valve is used, this must be carefully set as follows: Screw the adjustment knob all the way in and then back out by two turns. Have someone actuate the start valve and determine whether the engine starts. It should not start due to slow cranking. Open the adjustment knob until the engine cranks faster and just starts. Recharge the system and try the process again. Finally, open the knob further by half a turn and lock it using the lock nut below the adjuster.

Hydraulic starting systems require virtually no maintenance apart from replacing the filter element and a periodic check of the gas pre-charge pressure and the system pressure. Before undertaking any repair work ensure that the hydraulic system pressure is released. If in doubt, do not loosen anything and call for professional advice.

When having equipment repaired ensure that the work is carried out by an approved workshop equipped to test all components involved. This is particularly important with the accumulator which must be subjected to a rigorous inspection, be pressure tested under controlled conditions and have a test certificate issued on satisfactory completion of inspection and testing.

6. Warranty

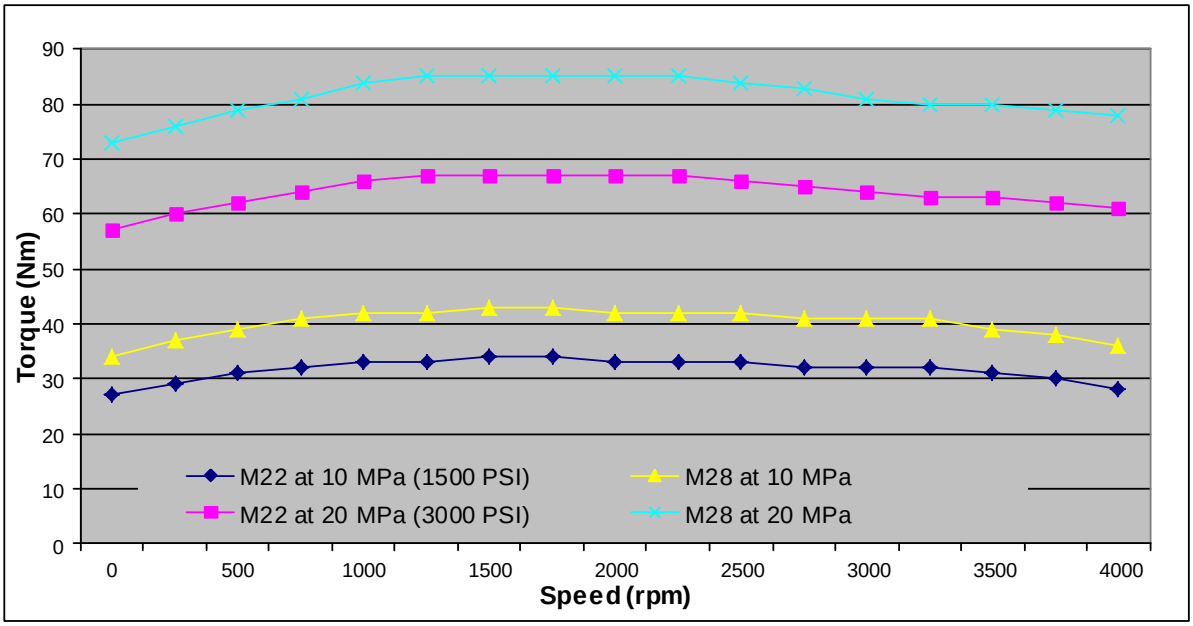
Powerworks warrants to the original user of the Powerstart starter that the starters are free from defects in material and workmanship for a period of one year from the date of purchase by such user. The conditions of this warranty are that: (a) Powerworks is notified within this period by return of such product to Powerworks or its authorised distributor or dealer, transportation prepaid by such user; (b) Such product has been installed and used according to its specifications; (c) Such product has not been misused, abused or improperly maintained by the user; (d) The defect is not the result of normal wear and tear, and (e) Such starter product has only been repaired by authorised service centres and with parts manufactured or authorised by the manufacturers.

Powerworks shall, at its option, either replace or repair, without charge, any such starter product found upon examination to be defective. Repairs or replacements under this warranty are warranted for the remainder of the original warranty period.

Powerworks makes no other warranty, and implied warranties, including any warranty or merchantability or fitness for a particular purpose are hereby disclaimed.

This warranty constitutes the entire obligation of Powerworks relating to the sale and use of this product and Powerworks's or its distributor's maximum liability is limited to the purchase price of such product at the date of purchase. In no event shall Powerworks be liable for incidental, indirect, consequential or special damages of any nature arising from the sale or use of such engine starter product.

7. Performance Curves and Specifications



		M22	M28
Specifications	Weight (typical)	12 kg	
	Construction	Cast iron	
	Max. working press.	21 MPa (3000 PSI)	
	Fluid media	Mineral oil	
	Viscosity range	ISO 32 to 46 (SUS 140-230)	
	Temperature range	-30°C to +100°C (-22°F to +212°F)	
	Speed range	0-4000 rpm	
	Rotation	CW - Standard (CCW - Optional)	
	Duty cycle	Intermittent	
	Overall volumetric efficiency	92% (minimum)	
	Displacement	22.1 cc (1.35 cu.in.)	28 cc (1.71 cu.in.)
	Max. torque at 210 Mpa (1500 psi)	66 Nm (49 lbf.ft.)	84 Nm (62 lbf.ft.)
	Max. power at 3500 rpm	24 kW (32 HP)	31 kW (41 HP)

8. Typical Schematics

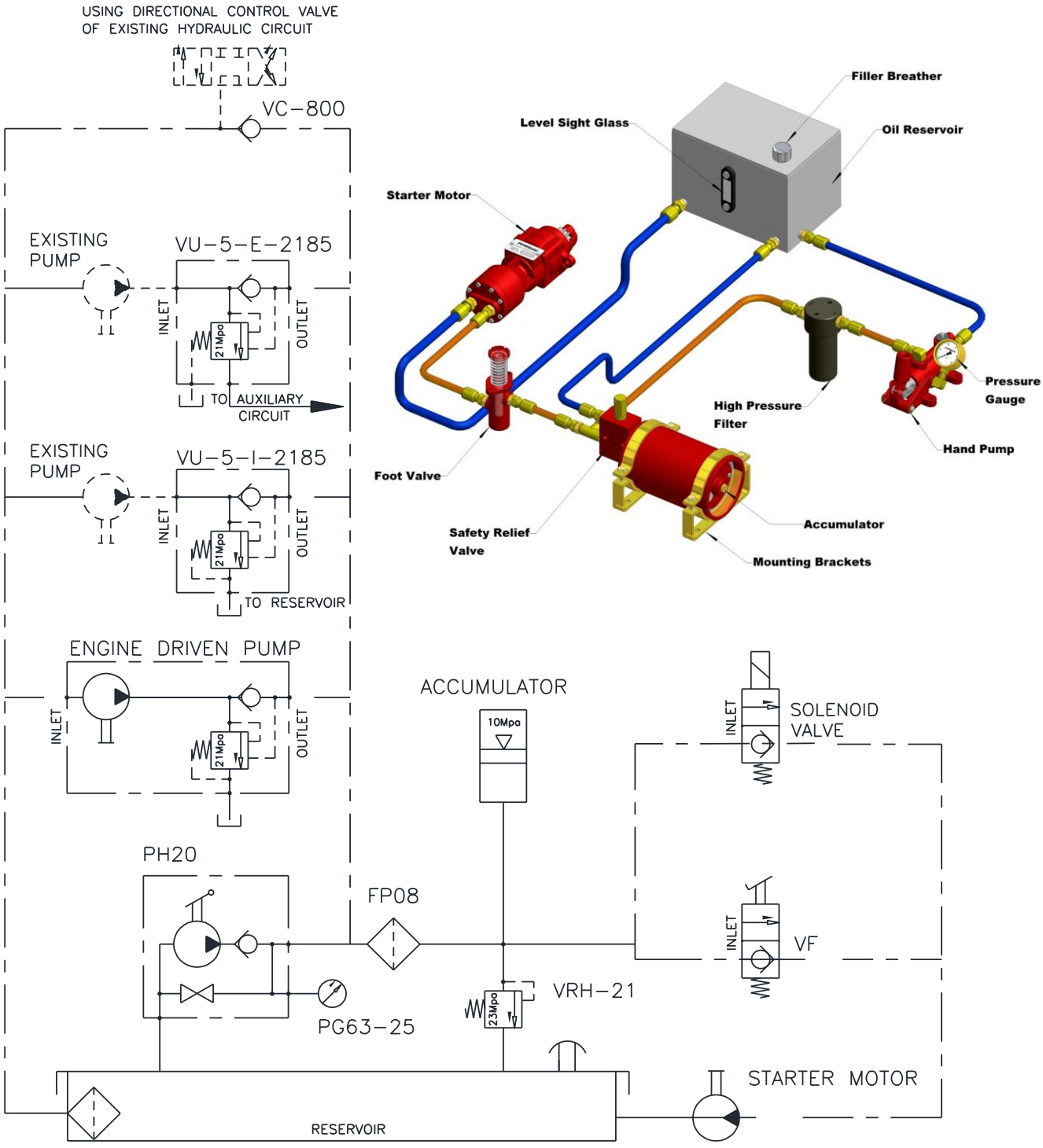
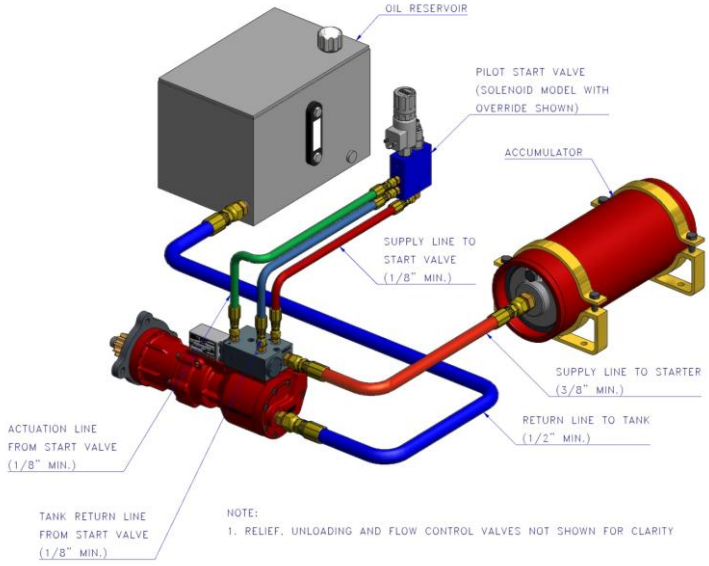


Fig. 1 – Powerstart Inertia starter typical schematic



TYPICAL HYDRAULIC SCHEMATIC

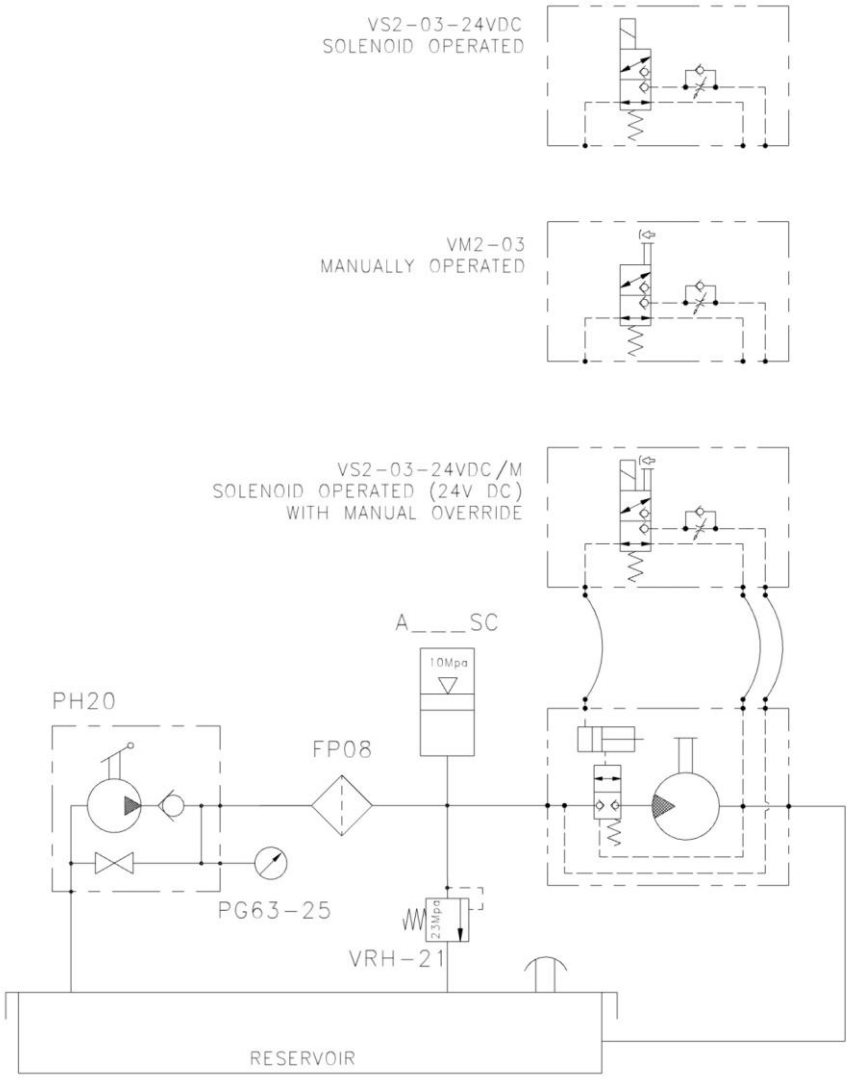
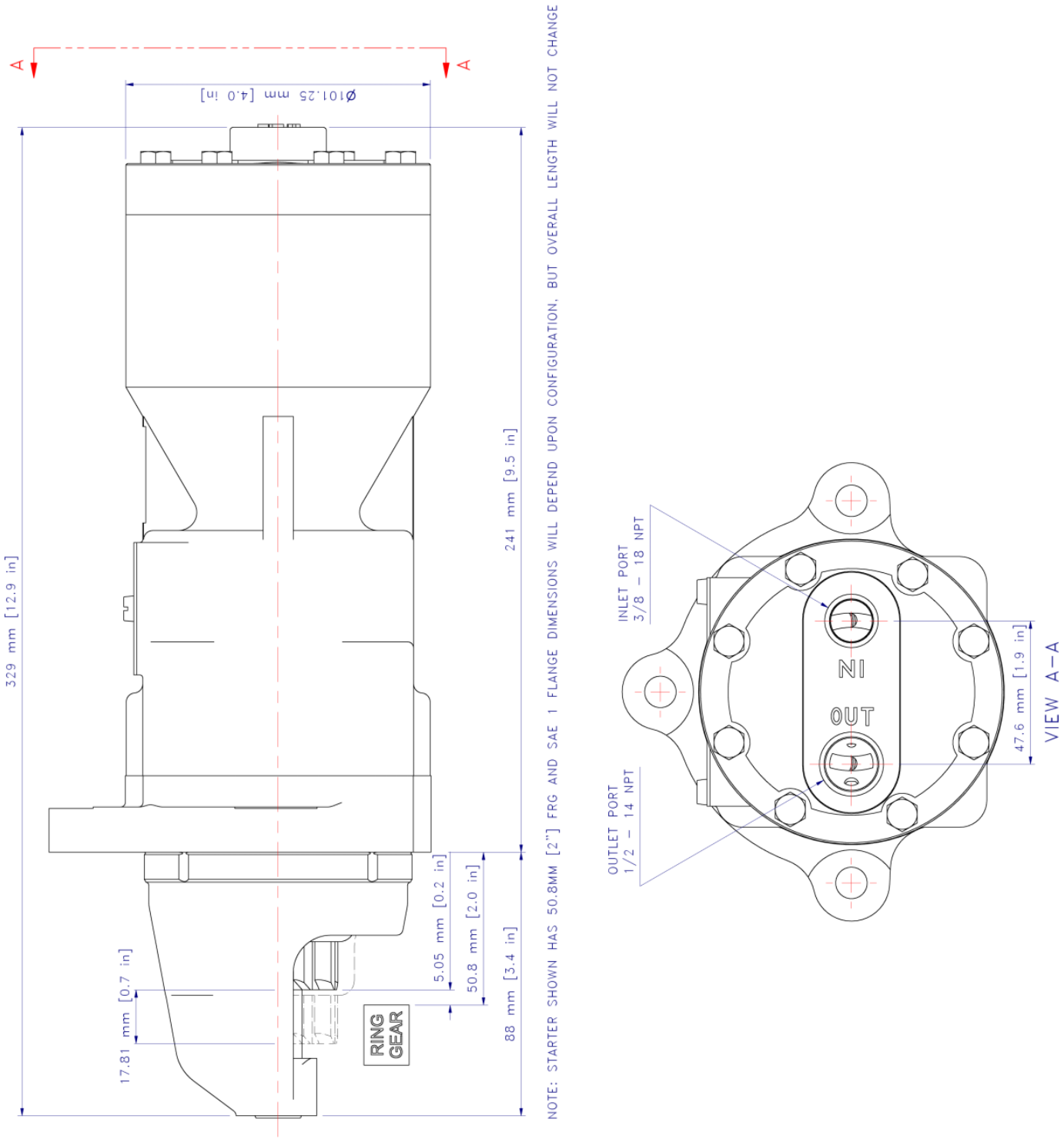
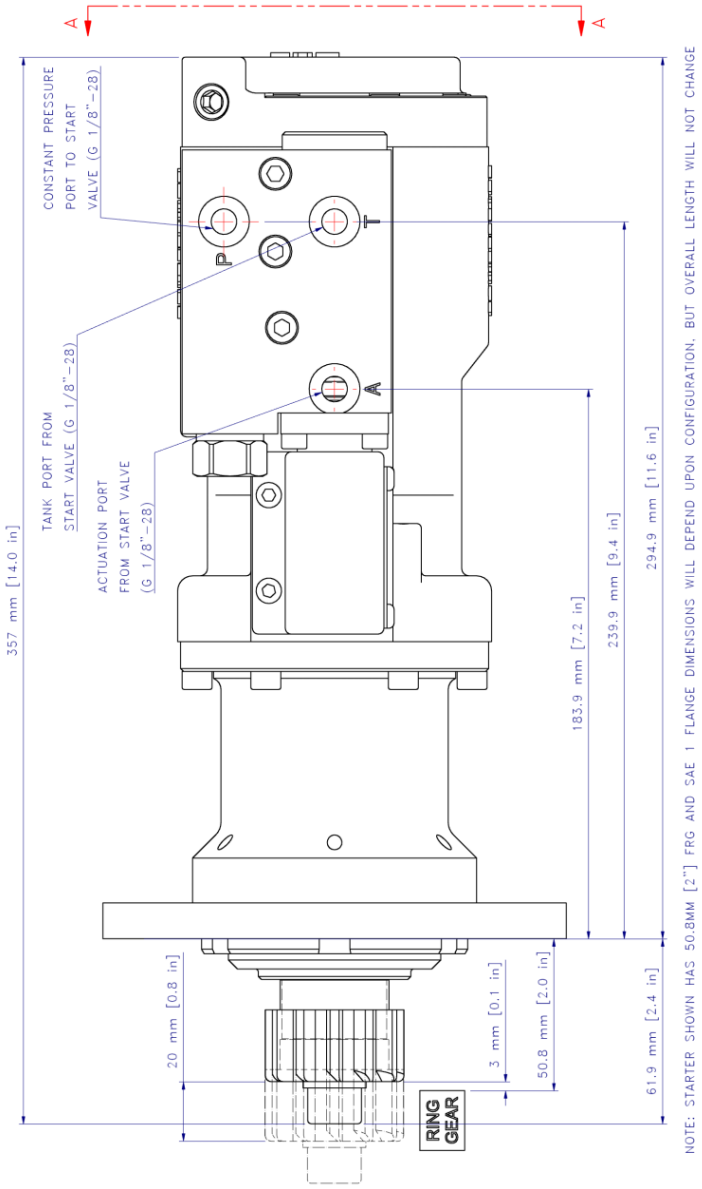


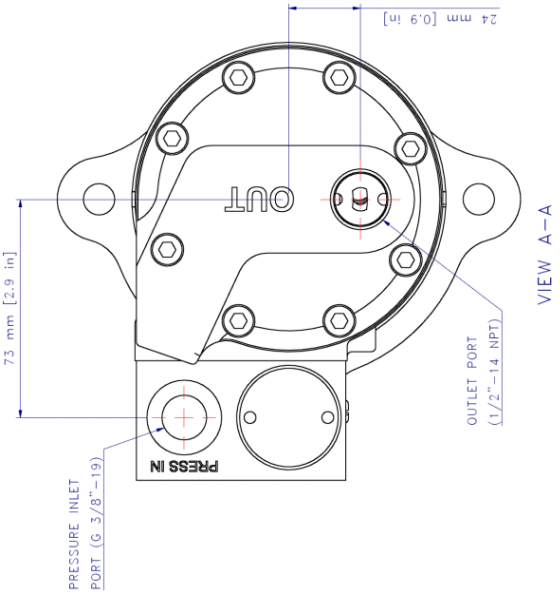
Fig. 2 – Powerstart pre-engaged starter typical schematic

9. M22 Inertia starter dimensions



10. M22 Pre-engaged starter dimensions


A
A
CONSTANT PRESSURE PORT TO START VALVE (G 1/8"-28)
TANK PORT FROM START VALVE (G 1/8"-28)
ACTUATION PORT FROM START VALVE (G 1/8"-28)
P
T
A
357 mm [14.0 in]
183.9 mm [7.2 in]
239.9 mm [9.4 in]
294.9 mm [11.6 in]
20 mm [0.8 in]
3 mm [0.1 in]
50.8 mm [2.0 in]
61.9 mm [2.4 in]
RING GEAR
NOTE: STARTER SHOWN HAS 50.8MM [2"] FRG AND SAE 1 FLANGE DIMENSIONS WILL DEPEND UPON CONFIGURATION. BUT OVERALL LENGTH WILL NOT CHANGE



11. Powerstart part numbering system

Starter model: **M** ___ ___ **-** ___ ___ ___ ___

Displacement

10	-	10cc (0.6 cu.in)
16	-	16cc (0.95 cu.in.)
22	-	22cc (1.35 cu.in.)
28	-	28cc (1.7 cu.in.)
38	-	38cc (2.32 cu.in.)
66	-	66cc (4.0 cu.in.)

Drive Type

D - Inertia
P - Pre-engaged (only M22)

Gear code

Refer to table

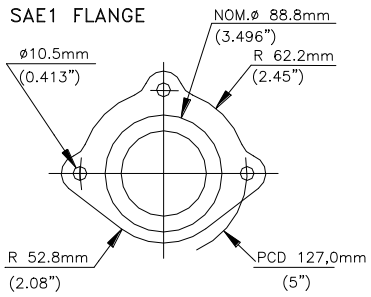
FRG (Flange to ring gear)

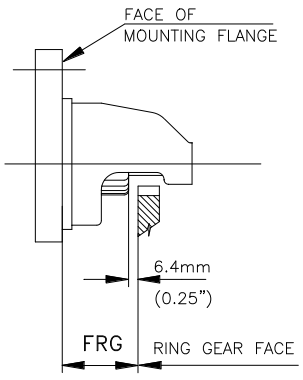
Refer to table

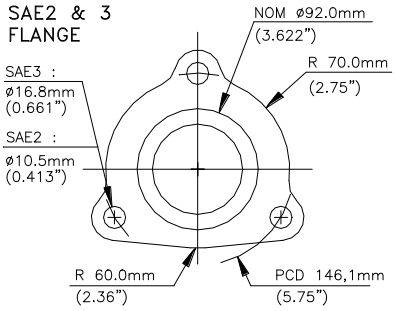
Flange Type

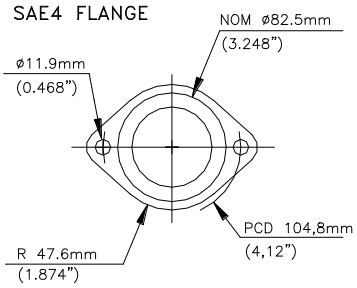
1	-	SAE 1
2	-	SAE 2
3	-	SAE 3
4	-	SAE 4

Numerous specials are available from Powerstart









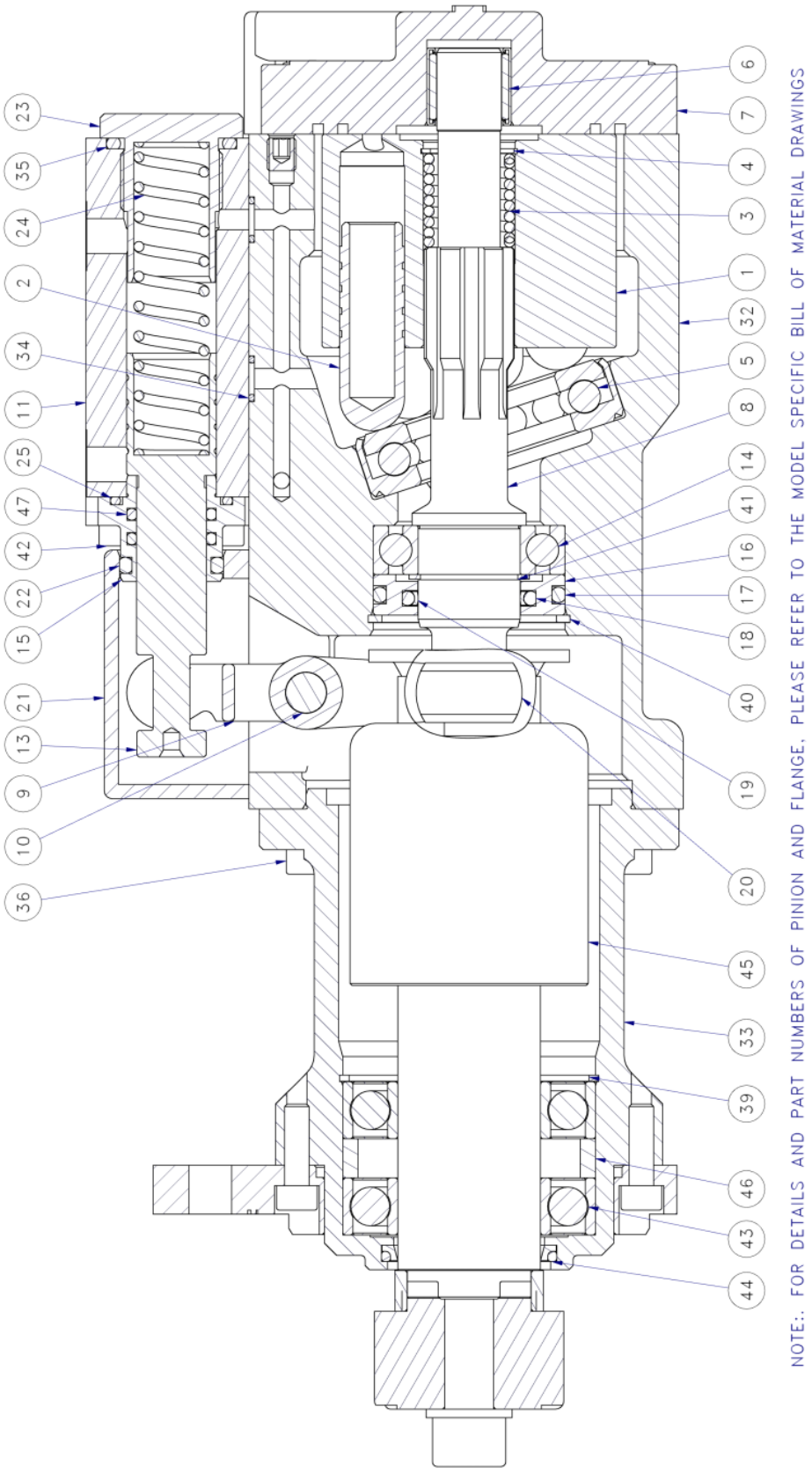
Gear Code	Teeth	D/P Mod	Press Angle	OD	PCD	Root min.	Root max.
				+0.05			
				-0.10			
1	11	6/8	20.0	57.1	46.6	42.9	43.5
2	12	8/10	20.0	46.4	38.1	34.9	35.4
3	10	8/10	20.0	40.0	31.8	28.6	29.0
4	11	3	14.5	41.1	33.0	27.5	28.1
5	9	3	14.5	34.5	27.0	21.0	21.6
6	13	8/10	20.0	46.4	41.3	34.9	35.4
7	12	6/8	20.0	57.1	50.8	42.9	43.5
8	11	8/10	20.0	44.0	34.9	31.2	31.7
9	9	2.75	14.5	33.0	24.8	20.6	21.1
A	15	10	20.0	44.4	38.1	33.0	33.5
B	11	3	14.5	41.9	33.0	28.5	29.1
C	14	10/12	20.0	41.9	35.6	32.8	33.2
D	10	3	14.5	38.1	30.0	24.5	25.1
E	10	10/12	20.0	32.2	25.4	22.6	23.0
F	20	10/12	20.0	58.1	50.8	48.7	49.1
G	9	2.5	14.5	30.0	22.5	18.8	19.2
H	13	3	20.0	47.0	39.0	33.5	34.1
J	12	7	20.0	54.5	43.5	38.1	38.8
K	9	8/10	20.0	36.8	28.6	25.4	25.9
L	11	8/10	20.0	40.0	35.0	28.6	29.0
M	10	12/14	20.0	26.9	21.2	18.7	19.1
N	11	10/12	20.0	34.7	28.0	25.2	25.6
P	11	2.5	14.5	35.0	27.5	23.8	24.2
R	9	3	20.0	36.0	27.0	23.2	23.7
S	15	4	14.5	70.6	60.0	52.6	53.3
T	13	10/12	20.0	39.8	33.0	30.3	30.7
U	13	10/12	20.0	38.7	36.1	29.1	29.5
V	11	3	14.5	40.0	34.0	26.5	27.1
W	9	3	20.0	35.0	27.0	22.5	23.1
X	11	3.5	14.5	48.2	38.5	32.5	33.1

Gear Code	Teeth	D/P Mod	Press Angle	OD	PCD	Root min.	Root max.
				+0.05			
				-0.10			
Y	13	3.5	14.5	56.4	45.5	41.0	41.6
Z	10	12/14		27.9	21.2	19.6	
AZ	13	3	14.5	48.4	42.4	34.9	35.5
BZ	11	8	20.0	40.5	34.9	26.8	27.4
CZ	15	3.5	14.5	61.9	54.9	46.2	46.8
DZ	9	12/14	12.0	25.8	19.1	17.6	18.0
EZ	13	3.5	14.5	57.8	45.5	42.0	42.7
FZ	9	10/12	20.0	29.6	22.9	20.1	20.5
GZ	11	7	20.0	48.0	39.9	30.6	
HZ	11	2.75	20.0	38.5	30.3	26.1	26.6
JZ	11	8	20.0	42.0	34.9	29.3	30.4
KZ	13	3.5	14.5	54.3	45.5	38.5	39.2
LZ	11	3.5	14.5	46.9	38.5	31.2	31.8
MZ	10	3.175	20.0	41.3	31.8	27.3	
NZ	10	8/10	20.0	38.4	33.4	27.0	27.5
RZ	13	3	14.5	46.6	39.0	33.1	33.7
SZ	10	8/10	20.0	40.5	31.8	28.6	29.0
TZ	9	3	14.5	35.1	27.0	21.6	22.2
UZ	9	3	14.5	36.2	27.0	22.7	23.3
VZ	13	3	14.5	47.4	39.0	33.6	34.2
WZ	13	2.5	14.5	40.8	32.5	29.6	30.0
XZ	11	3	20.0	41.1	33.0	27.6	28.2
YZ	9	10	20.0	29.9	22.9	18.5	18.9
ZZ	13	10/12	20.0	40.7	27.5	30.0	
AY	9	2.75	20.0	33.0	24.7	20.6	21.1
BY	9	3	14.5	34.7	27.0	21.6	22.2
CY	10	8/10	20.0	39.5	31.8	28.1	28.6
DY	11	8/10	20.0	43.2	34.9	31.8	32.2
EY	12	8	20.0	47.2	38.1	34.0	34.6
FY	9	3	14.5	34.5	27.0	21.0	21.6

Flange to Ring Gear Code Table

Code	S	1	4	5	6	7	8	9	A	C	D	E	F
FRG	50.8	29.0	25.5	42.0	23.0	55.0	31.5	45.0	13.0	19.0	16.0	74.0	38.1

13. M22 Pre-engaged Starter Cross-section



14. M22 Pre-engaged starter parts list and service kits

Item	Qty	Part Number	Description	Quantity in service kit M22-RK2
1	1	M22-04	BARREL	
2	7	M22-05	PISTON	
3	1	M22-06	SPRING	
4	1	M22-07	CIRCLIP, BARREL	1
5	1	M22-08	THRUST BEARING	
6	1	M22-10	NEEDLE BEARING	1
7	1	M22-52	PORT PLATE	
8	1	M22-53	SHAFT	
9	1	M22-54	YOKE	
10	1	M22-55	PIVOT PIN, YOKE	
11	1	M22-56	VALVE BLOCK	
12 *	1	M22-57	CARTRIDGE	
13	1	M22-58	PISTON	
14	1	M22-59	BEARING, CENTRE	1
15	1	M22-60	GLAND	
16	1	M22-61	SEAL HOLDER	
17	1	M22-62	O-RING, HOLDER	1
18	1	M22-63	O-RING, INNER	1
19	1	M22-64	SLIPPER SEAL	1
20	2	M22-65	PUSHER PAD	
21	1	M22-66	COVER	
22	1	M22-67	O-RING, OUTER	1
23	1	M22-68	END CAP	
24	1	M22-69	SPRING	
25	1	M22-70	O-RING, GLAND FACE	1
26 *	2	M22-71	O-RING	2
27 *	2	M22-72	SCREW, NAME PLATE	
28 *	1	M22-73	NAME PLATE	
29 *	2	M22-75	ALIGNMENT PIN	
30 *	1	M22-76	LOCK PIN, YOKE PIVOT	1
31 *	1	M22-77	PLUG, PORT PLATE	
32	1	M22-80	HOUSING, REAR	
33	1	M22-81	HOUSING, FRONT	
34	3	PH20-20	O-RING	3
35	1	PH20-22	O-RING, END CAP	1
36	6	TC-101	RETAINER, FRONT	
37 *	7	TC-103	RETAINER, PORT PLATE	
38 *	4	TC-104	RETAINER (40MM)	
39	1	TC-17	RETAINING RING	
40	1	TC-27	CIRCLIP, ANNULUS	1
41	1	TC-28	CIRCLIP, SHAFT	1
42	6	TC-43	RETAINER, PORT PLATE	
43	2	TC-65	BEARING, FRONT	2
44	1	TC-66A	WIPER SEAL	1
45	1	TJ-140	DRIVE ASSEMBLY	
46	1	TR-64B	SPACER, BEARING	
47	2	VF-06	O-RING	2

* - Denotes parts not visible on the cross section